

Water Reading Seminar

As Utah is the second-driest state in the nation, fresh water is a precious resource. Even though water is a familiar substance it is a very peculiar compound. Water has some exceptional qualities that will be examined in the following paragraphs. When electrons are not shared equally in a covalent bond, the molecule is described as polar. This means that while water molecules are neutral as a whole, one end of the water molecule tends to have a positive charge while the other has a negative charge. Each end of a water molecule is attracted to the opposite charged end of another water molecule. Consequently, water's polarity is responsible for the "stickiness" or cohesion between the molecules.

Cohesion of water causes capillary attraction, the ability of water to move uphill in small spaces. Water will move up the fibers of a plant because of cohesion. This force helps plants get the water they need to survive. In addition, it moves water upwards in soil. Cohesion of water also causes surface tension, water's invisible skin which allows water striders to walk on water.

Polarity is also related to solubility. Polar substances can dissolve other polar substances. Non-polar substances dissolve other non-polar substances. Polar substances and non-polar substances, however, do not mix. Dirt sticks to clothes and skin because it is combined with a thin layer of oil. Because water is polar and oil is non-polar, washing clothes in water alone does not remove all the dirt. This is why soap is used to clean clothes.

While one end of a soap molecule dissolves in water, the other dissolves in oil. This special dual ability of soap permits it to break up dirt so it can be removed easily. The polar end of the soap molecule dissolves in the water while the non-polar end dissolves in the oil. In this way, the oil is broken into droplets, surrounded by soap molecules, and dispersed. The droplets of oil do not merge together because the polar ends of the soap molecules have similar charges and repel each other. Because soap does not work very well in hard water, phosphates are often added to laundry detergents. The addition of phosphates to lakes can initiate the process of eutrophication.

Phosphates and nitrates are nutrients that algae use for growth. When these nutrients are available in abundance, algae may undergo explosive growth: an algae bloom. Eventually the bloom will die off and sink. Bacteria will then break down the dead plant material. These bacteria use up most of the oxygen dissolved in the water, leaving fish and other animals that live near the lake bottom to suffocate. This process, called eutrophication, is set in motion when excessive amounts of phosphates and nitrates enter the natural ecosystem. Some sources of these dissolved nutrients include raw sewage, fertilizer run off, detergents, and animal wastes.

When the algae bloom dies off, it will sink to the bottom of the lake because it is more dense than water. In the same way cold water and salty water tend to sink to the bottom because of their density. This is a major cause of deep ocean currents. When ice freezes

near the poles, the salt concentrates in the liquid water of the ocean. The remaining water becomes more salty and therefore more dense. The dense, salty water sinks deep into the ocean and creates a current. The density of water increases with depth. Some animals change their depth by changing their density. Recall that things that are more dense than their surroundings sink while those that are less dense than their surrounding float. Most fish have a swim bladder, a special sac that is filled with gases from their blood. When the fish's swim bladder is full, it is less dense than the surrounding water and the fish will rise towards the surface.

Another property of water that affects lakes is the unique changes in density during phase changes. The density of most substances increases when a liquid becomes a solid. This is not so for water: Solid water is actually less dense than liquid water. It is for this reason that ice floats. Can you imagine a world where ice sank? Lakes would freeze from the bottom up, killing many fish. Frozen water in the polar regions would sink and change the ocean levels. The fact that ice floats is essential for the survival of many aquatic ecosystems and ultimately life on Earth

Besides the changes in density, there are other ways in which the phase changes of water have significant impacts. When water is trapped in small cracks in rocks, it will expand as it freezes and break up the rock causing weathering. The transpiration of water from a good-sized tree can move 1800 liters of water out of the ground in a single day. Sublimation, the phase change between solid and gas, is responsible for the formation of frost.

As you can see, water has many special properties that make its role in nature unique. One of water's special characteristics is the "stickiness" between water molecules. This quality helps water to move through plant fibers. The cause of this "stickiness" also makes water an excellent solvent. In fact, water is considered the "universal solvent", able to dissolve a wide variety of substances. Even so, detergents are used to enhance water's ability to dissolve dirt. Phosphate, compounds that are added to detergents, can have a serious impact on lakes when they increase the growth rate of algae. Another way that lakes are affected by one of water's strange characteristics is how water freezes. Contrary to other substances, water is less dense in its solid form than in its liquid form, hence a solid that floats! Water is the only substance that occurs naturally in all three states. The characteristics examined in the paragraphs above are: capillary attraction, surface tension, solubility, density, and phase changes.